Terrain Database Rendering Issues and Best Practices

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Outline

- Database Rendering Challenge
- Error management
- Time management
- Geometry management
- Sampling
- Cultural Features
- Future

Database Rendering Challenge

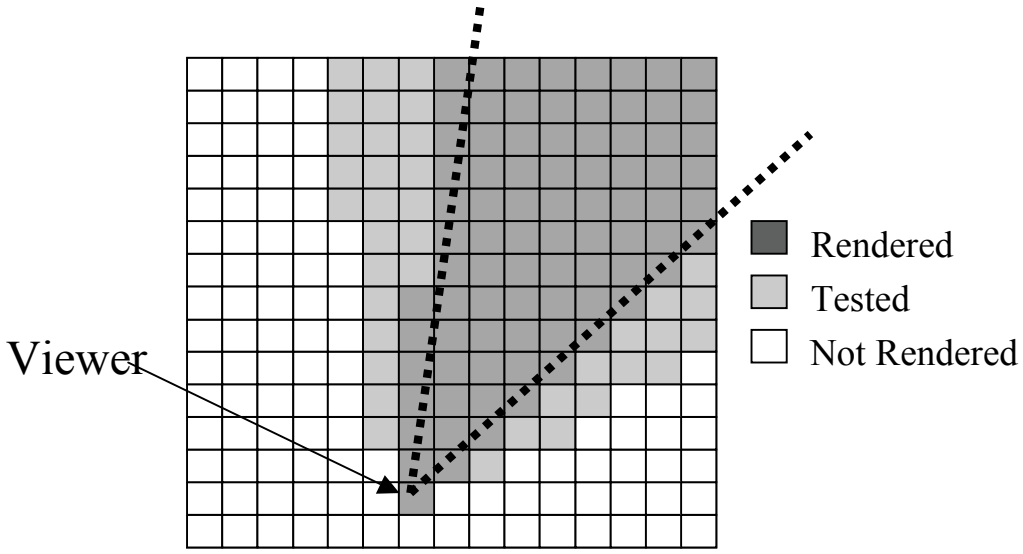
- More source elevation data than can be effectively rendered in real-time.
- Asheville, NC database had 4,142,307 source elevation points. This equates to about 8,284,614 triangles.
- Rendering at 20 frames per second would require the processing of 165,692,280 triangles per second.
- Source data has to be sampled. Sampling introduces error.

Error Management is Time Management

- Since sampling introduces error, the less amount of sampling involved, the less error introduced.
- In general, the more triangles actually visible in a frame, the more accurate the terrain display.
- Primary resource in rendering is time.
- So it follows, that the more time that can be spent on actually rendering triangles, the less error the rendered display will have.

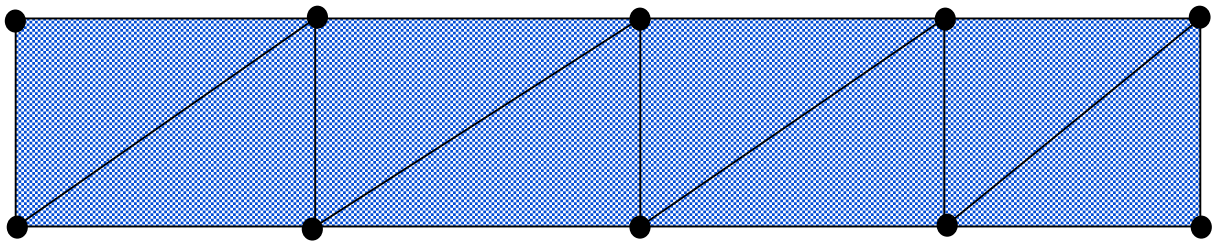
Time Management: Field-of-View Culling

- First step is to only spend time processing triangles that are going to be seen.
- This allows more resources to be spent on drawing visible triangles, thus increasing the visible triangle count.
- Field-of-view culling is one way to achieve this.



Time Management: Triangle Meshing

- Save time by drawing triangles efficiently.
- Vertex processing rate largest time consumer.
- Triangle meshing draws a new triangle by using two of the vertices of the previous triangle.
- This can significantly reduce the number of vertices that need to be transform.
- A triangle mesh of eight triangles requires only ten vertices to be transformed. 1.25 vertices per triangle.



Error Management is Geometry Management

- Draw triangles where they will be useful.
- The farther a feature is away from the viewer, the less detail (fewer triangles) required.
- The more planar a feature, the less triangles required to define the shape.

Geometry Management: Level-of-Detail

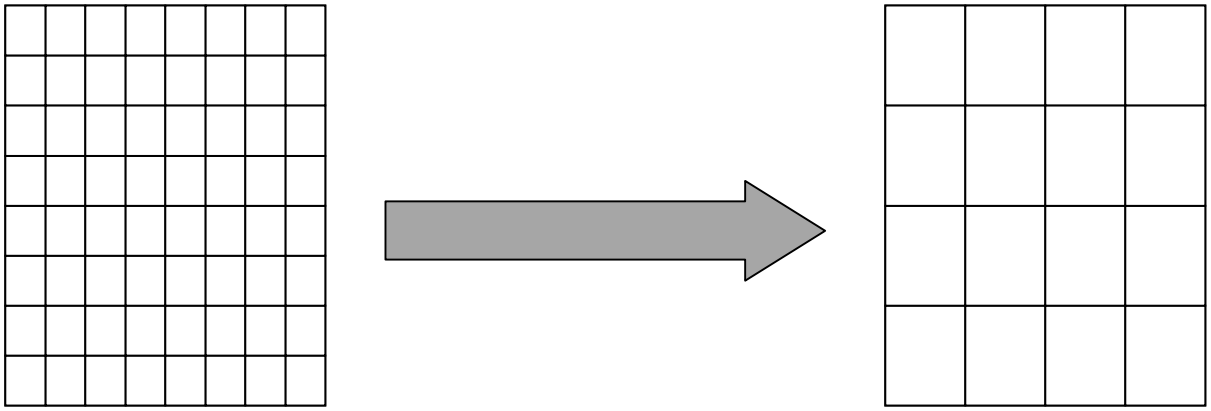
- Level-of-Detail (LOD) is the process in which more polygons are used to render an object as the object gets closer to the viewer.
- The LOD mechanism has been used object models for a long time.
- Comparatively, LOD has been just recently applied to terrains.

Geometry Management: Level-of-Detail

- Terrain is too large to use standard object model LOD approach.
- Break terrain into rectangular regions (quad-tree, regular grid).
- Apply LOD process to each grid independently from other grids. This is where sampling occurs.
- Type of sampling has effect on error.
- Edge coherency issues arise at grid edges that generate visual artifact problems.

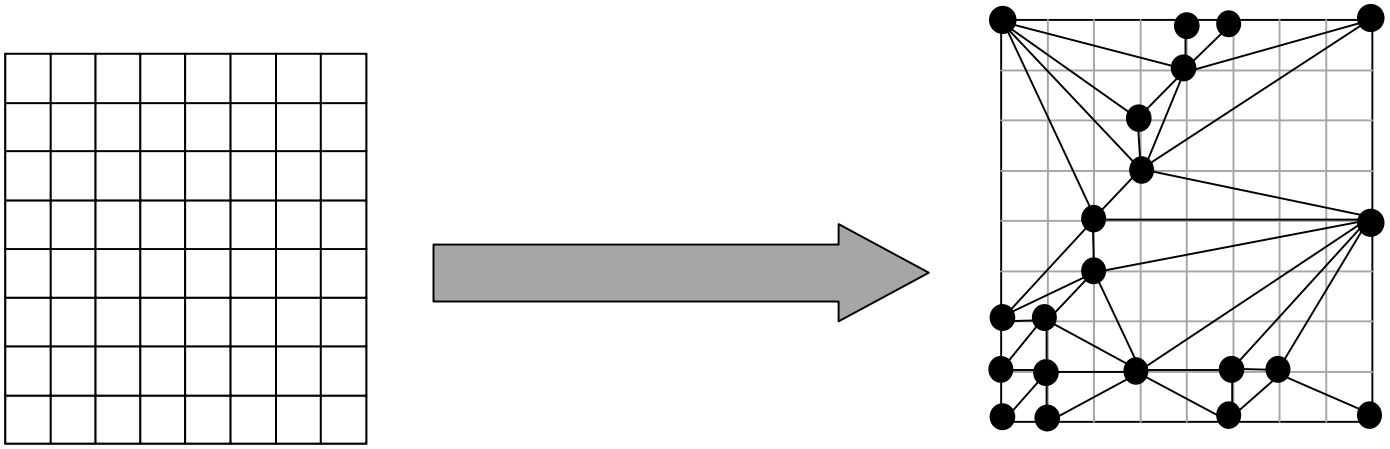
Geometry Management: Sampling

- Simple sub-sampling is easiest.
- Generates long triangle-meshes for good triangle rendering efficiency.
- Does not consider topology and can introduce large amounts of error.



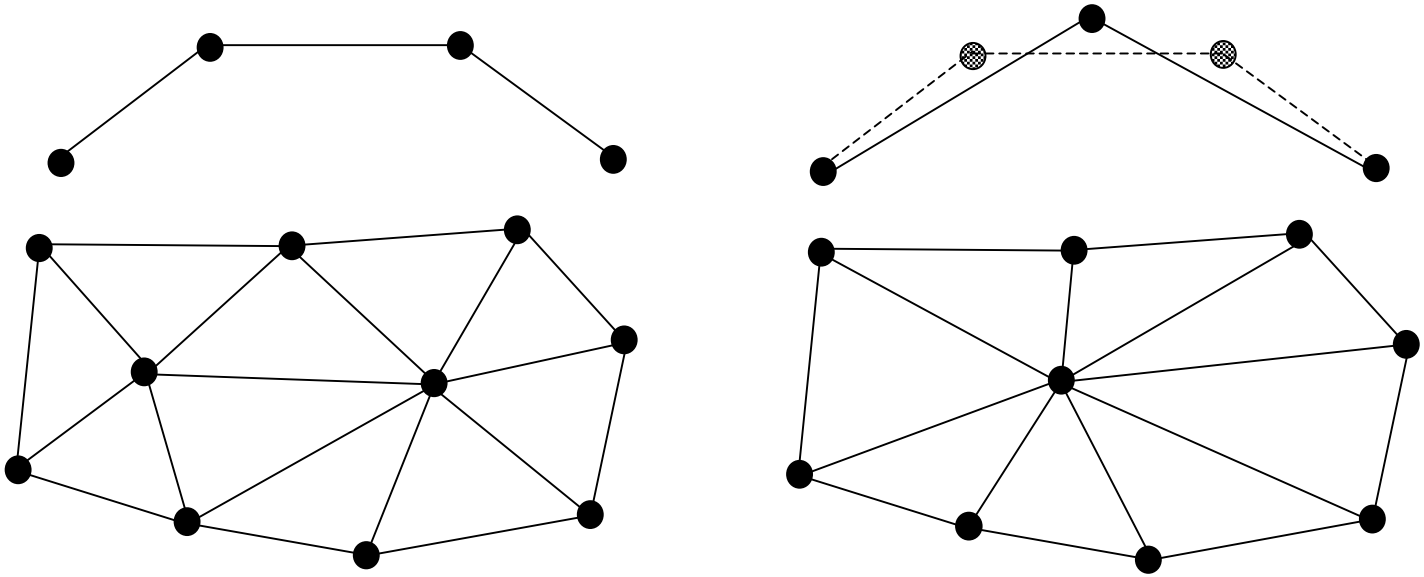
Geometry Management: Sampling

- Delaunay triangulation with error criteria adds points with highest amount of error first.
- Process is stopped when either a triangle limit is reached, or the amount of error falls below a set criteria.
- Typically generates triangle strips on the average of 5 to 6 triangles in length.



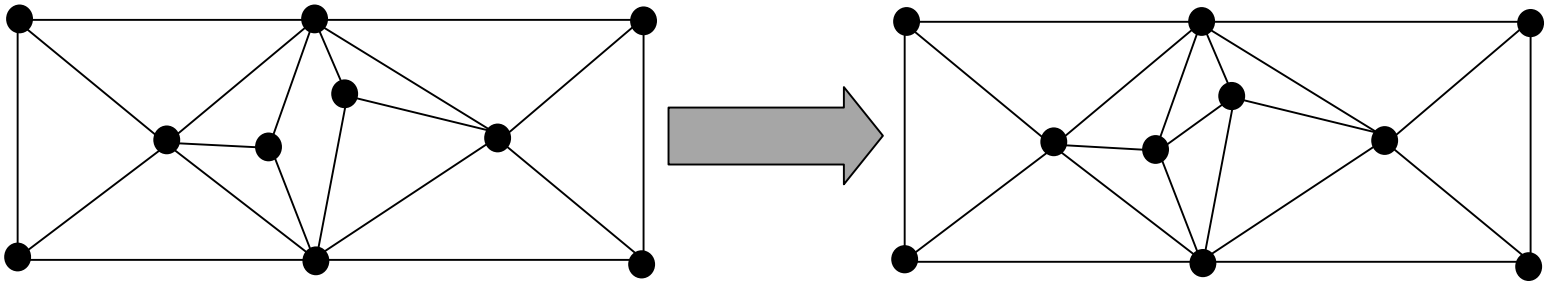
Geometry Management: Sampling

- Decimation starts with fully triangulated model and collapses edges one at a time.
- Process is stopped when either a triangle limit is reached, or the amount of error increases above a set criteria.
- Adds new vertices that were not in original data set.
- Has the lowest error with the fewest triangles.



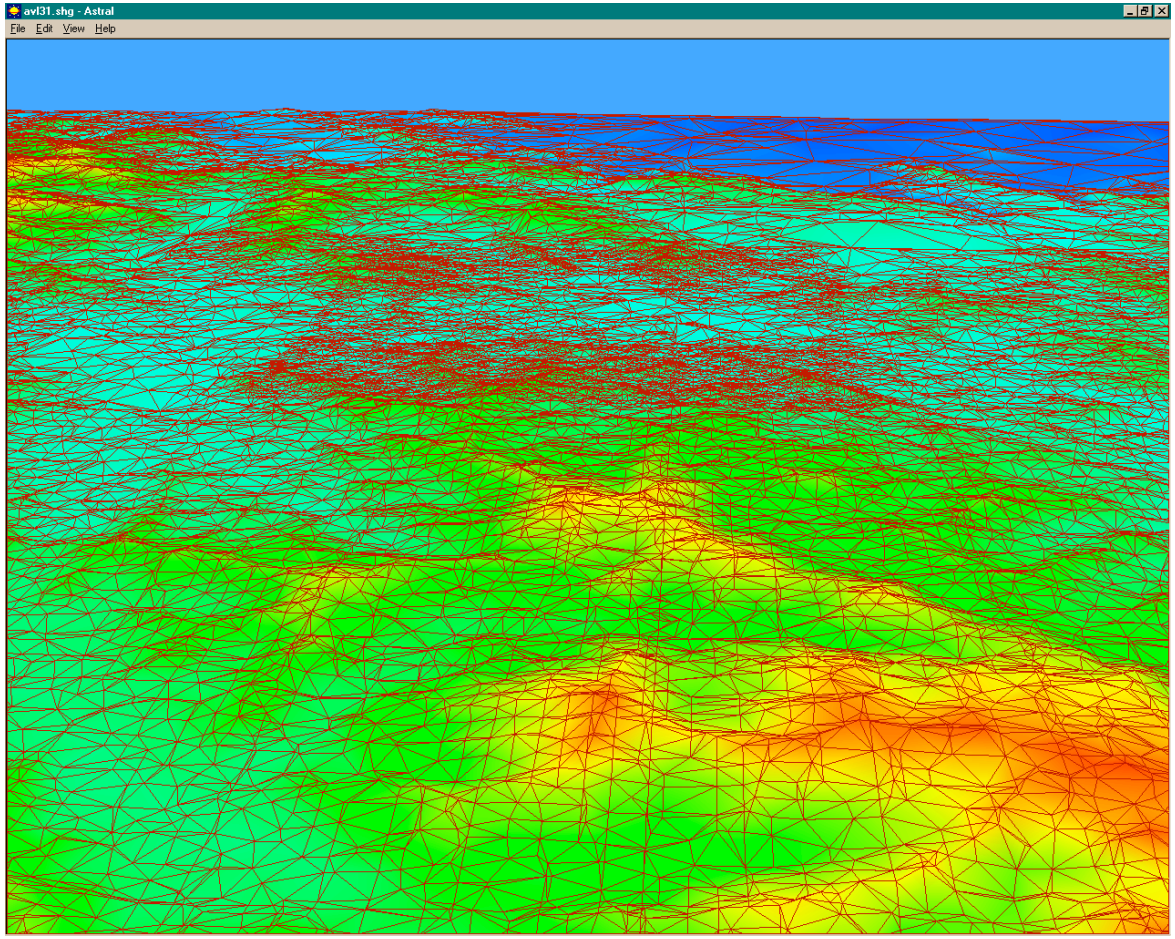
Geometry Management: Edge Coherency

- All gridded LOD terrains have edge coherency issues.
- These occur when one grid is at a different LOD range than an adjacent grid.
- The terrain will have tears at these junction areas unless additional geometry is added.
- Usually there is a post-processing step that generates new glue geometry that connects adjacent LOD grids.



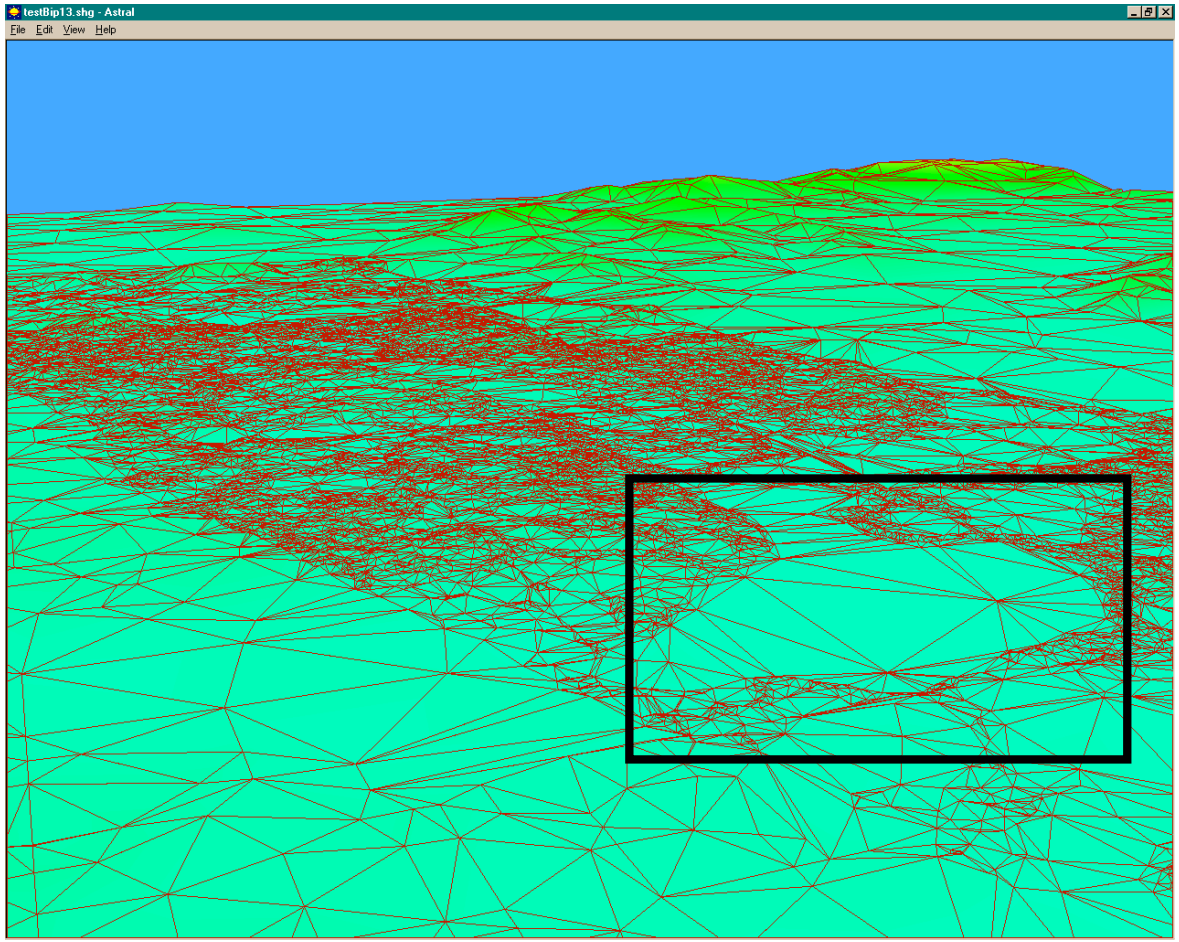
Database Example

- Gridded LOD terrain generated with Delaunay error criteria point insertion.



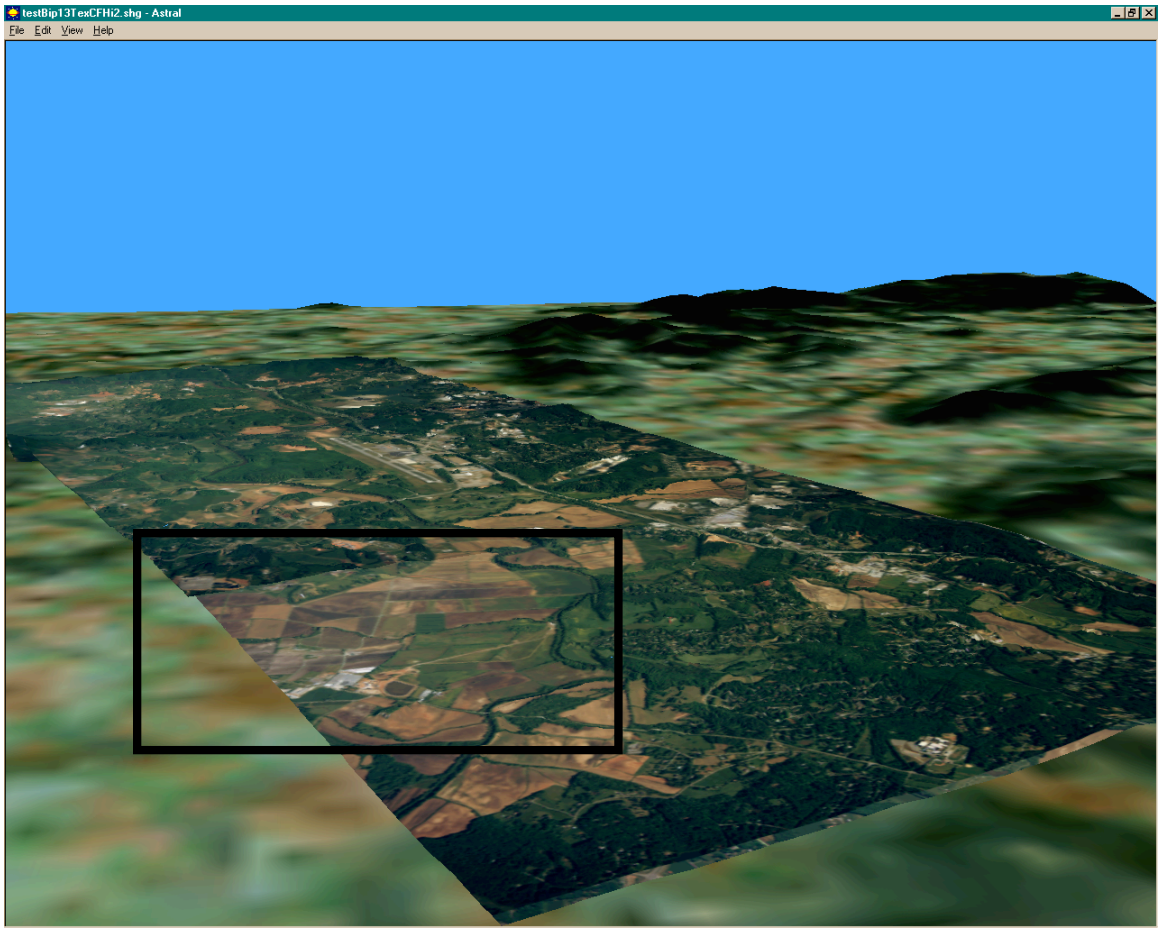
Database Example

- More triangles where the detail is needed.



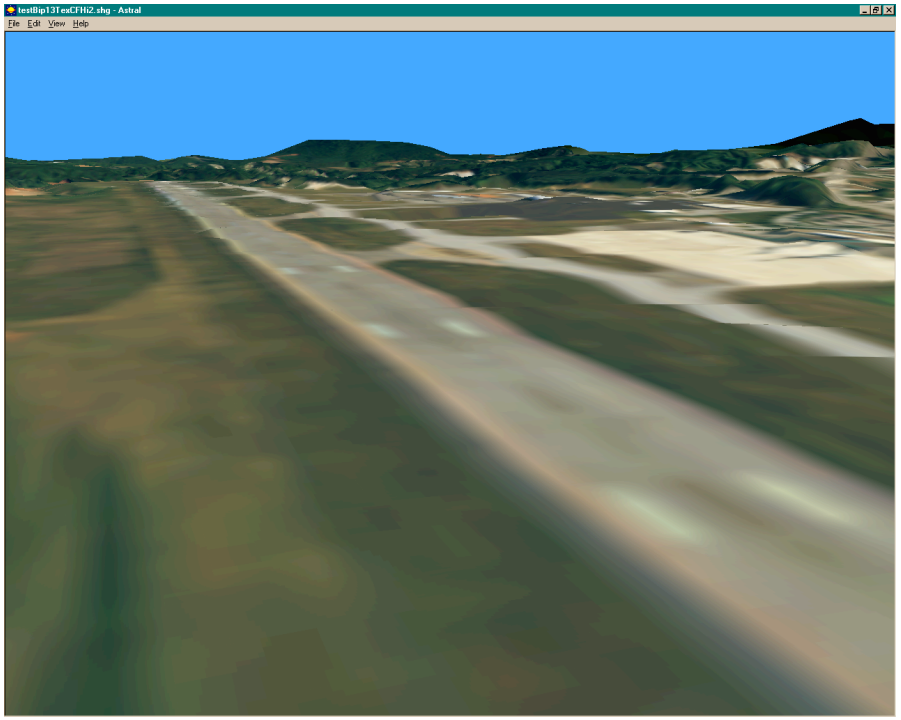
Database Example

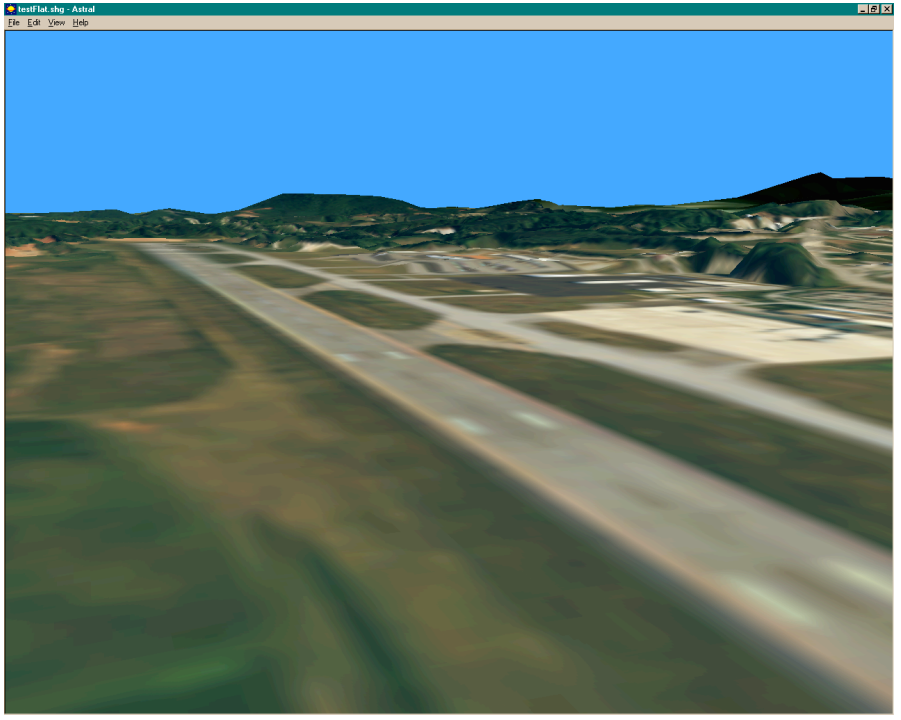
- Texture shows that flat area of few triangles in previous slide are fields.



Database Rendering: Cultural Features

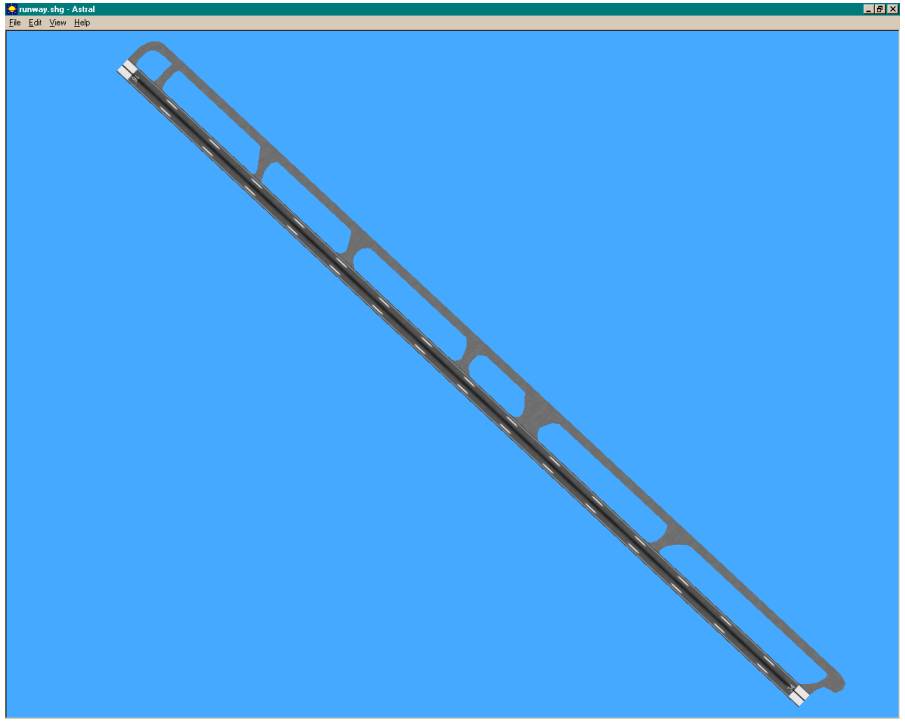
- Survey locations of cultural features does not agree with elevation data.
- Area must the be processed.





Database Rendering: Cultural Features

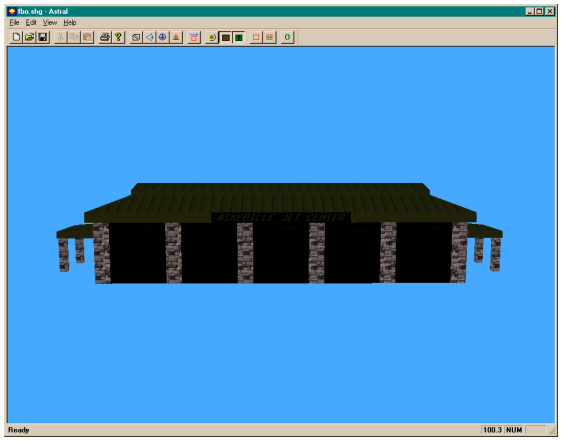
- Use of geometry models for cultural features helps dramatically with visual effectiveness.

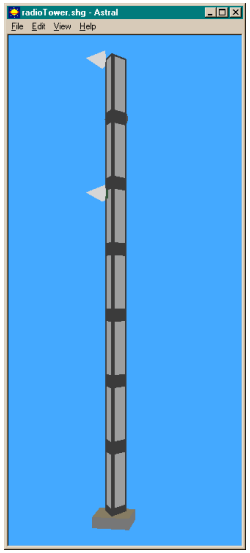


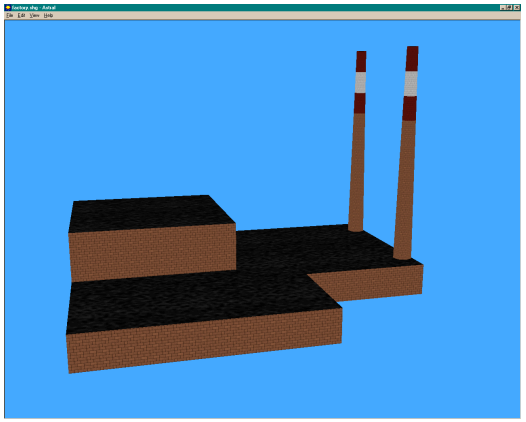
Database Rendering: Cultural Features

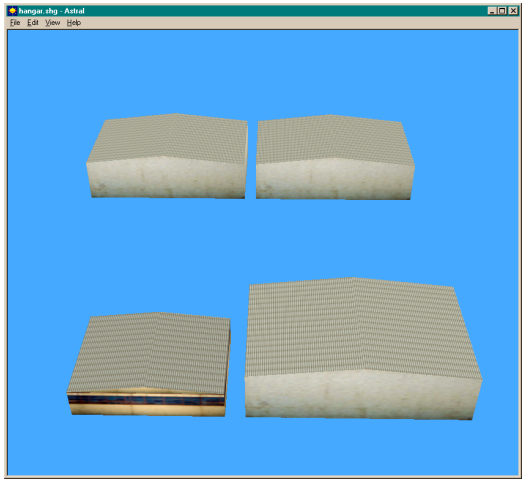
- Building and obstacle models generated in modeling package.
- Buildings placed on terrain by location in texture image.
- Obstacles placed by surveyed obstacle locations.

Database Rendering: Cultural Features









Database Rendering: Cultural Features

Database Rendering: Future

- Dynamic LOD size and locations.
- Curved Earth representation.
- Auto generation of runway and obstacle models.
- Higher density data more accurately represented with better sampling procedures and time management.